Optically active photonic crystals by holographic lithography

O. M. Roche[1], D. N. Sharp[1], E. R. Dedman[1], C. F. Blanford[2], R. G. Denning[2] and A. J. Turberfield[1].

[1] University of Oxford, Department of Physics, Oxford OX1 3PU, U.K.

[2] University of Oxford, Inorganic Chemistry Laboratory, Oxford OX1 3QR, U.K.

We demonstrate the use of chiral microstructure to make an optically active photonic crystal from material that is non-chiral in its bulk form. Face-centred cubic photonic crystals with a chiral basis are produced by holographic lithography.

Holographic lithography is a technique for the fabrication of 3D photonic crystals in which a 3D periodic interference pattern formed at the intersection of four laser beams is used to expose a thick layer of photoresist. Highly exposed photoresist is rendered insoluble while underexposed areas are washed away to reveal a polymeric photonic crystal with interconnected air voids. By controlling the polarizations of the interfering plane waves, which are used to define the 3D microstructure, it is possible to create left- and right-handed and closely-related non-chiral structures. The critical effect of structural chirality on the band structure of a photonic crystal is to produce non-degenerate circularly polarized bands. The result is optical activity that is produced entirely by the chiral microstructure created by holographic lithography. We anticipate that by combining the molecular-scale chirality of an infiltrating liquid crystal and a photonic crystal with engineered structural chirality it will be possible to achieve a high degree of flexibility in the design of polarization-sensitive photonic crystal devices.